Space Weather Technical Forecast

Issued on Monday, 26 February 2024 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing likelihood of M-flares with a slight chance of X-flares due to AR3590. Chance of G1/Minor Storm intervals on day 1 (26 Feb)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate, with the largest flare peaking at M2.0 at 25/1722 UTC from AR3590 in the northwest disc. Of the six numbered sunspot regions, AR3590 was the source of all the notable flares and remains the largest and most complex region on the Earth-facing Sun. The region initially underwent a very slow increase in areal extent, with a large but weak delta spot comprised of the strong leader spot and a strong intermediate spot. Further much smaller delta spots were, and are still evident, including to the east of the intermediate spot, leading to some subtle complexity, despite the relatively simple east-west aligned nature of the region. No noteworthy dynamical changes occurred with the magnetic configuration of the region, and given the limited shear across the spot, this likely resulted in a general reduction of flare activity. Later in the period a slight reduction in penumbral extent was observed from this region. Elsewhere, the majority of spots remain largely inactive, although there was some minor development of newly numbered AR3595 in the northeast.

There were no Earth directed CMEs observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds were observed at background to slightly elevated levels, with ongoing but limited influence from a weak, glancing CME that arrived late on 24 Feb. Speeds varied between 350-460km/s. Density was mainly average, but rose to peak at nearly 17pppc at 25/2108 UTC. Total Interplanetary Magnetic field (IMF) strength, Bt, was predominantly moderate, peaking 14nT at 25/1924 UTC. The north-south component was largely weak to moderately negative (southward) until around 25/1300 UTC, then mainly weak to moderately positive (northward). From approximately 25/2300 UTC the Bz became weak to moderately negative again. Values ranged between +13nT and -10nT. Phi angle was mainly negative (towards from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux reduced from slightly elevated to ambient background levels, with observed values well below the S1 Minor Solar Radiation Storm level. Electron flux (greater than 2MeV) observed at GOES16 has been at normal background levels, with electron fluence well below the Active (1e8 integrated pfu) threshold. The observed 24-hour fluence at 26/0000UTC was 8.57e5 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to Low activity is expected with further isolated M-flares considered likely. There remains a slight chance of isolated X-class flares from AR3590.

Solar Wind / Geomagnetic Activity: Near background solar winds are expected to become elevated on day 1 (26 Feb), resulting from the onset of the fast wind from a coronal hole fast wind, before easing day 2 (27 Feb) onwards towards background levels again. Quiet to Unsettled geomagnetic activity at first, becoming Unsettled to Active with a chance of G1 Minor Storms from the coronal hole fast wind onset on day 1 (26 Feb). Quiet to Unsettled activity expected days 2-4 (27-29 Feb).

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Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is expected to remain at background levels, but with a risk of becoming enhanced in the circumstance of any further significant flares from AR3590 in the northwest. This giving a slight chance of exceeding the S1 Minor Radiation Storm level. High energy electron flux (greater than 2MeV) is expected to persist at background at first. An increase to Moderate or High levels is then possible from day 2 (27 Feb) onwards in response to any solar wind enhancement from the coronal hole fast wind onset. 24-hour electron fluence is expected to stay below the Active (1e8 integrated pfu) threshold, but with a rising trend, giving a very slight chance of reaching Active by days 3-4 (28-29 Feb).

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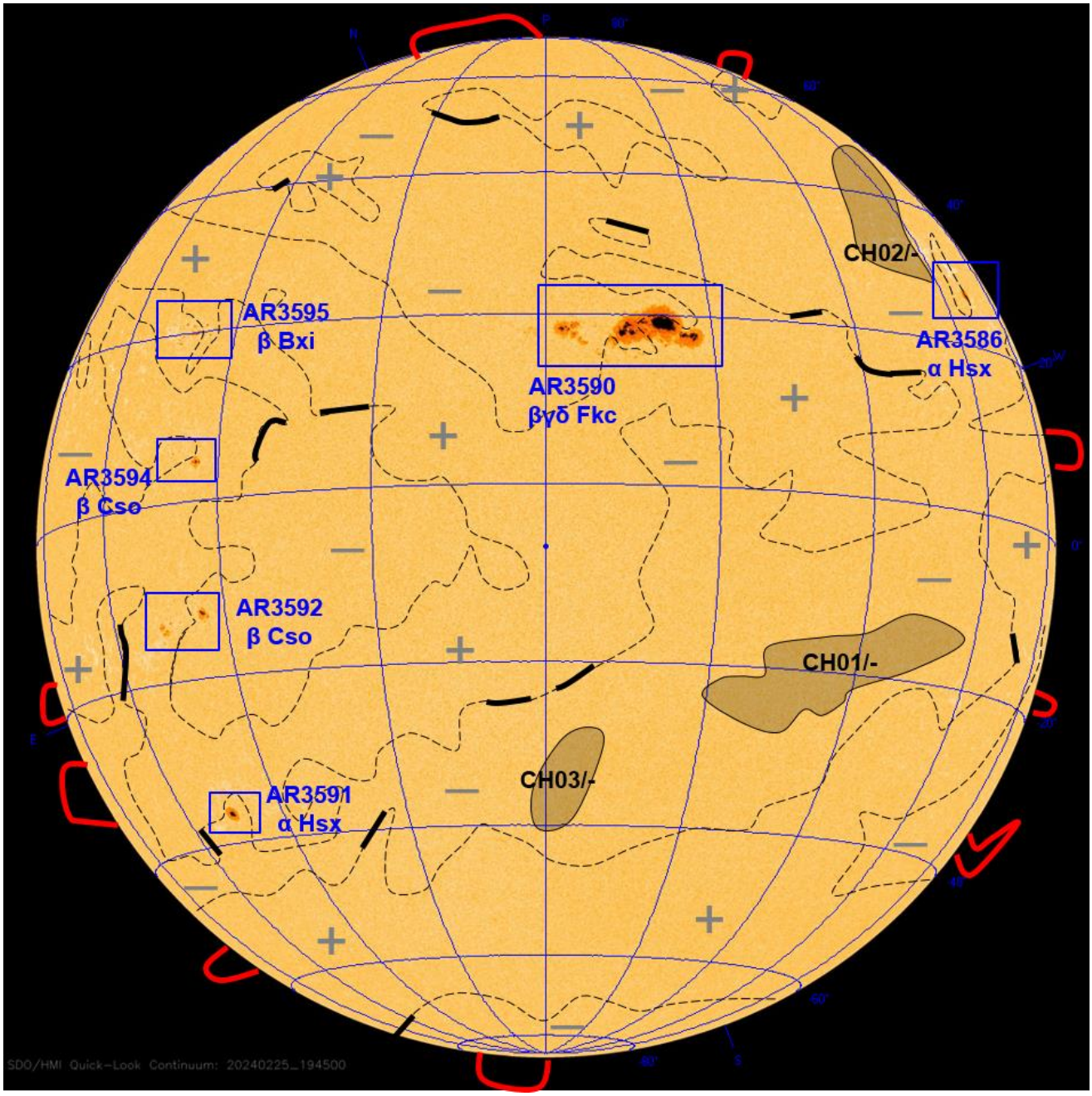
Figure 1. Solar Analysis Valid 25/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs.

A weak enhancement to the solar wind early on 25 Feb was most likely to be due to ongoing CME effects from the weak glancing arrival on 24 Feb, with winds varying between background and slightly elevated levels. The fast wind of CH01/+ is expected to become geo-effective through the next 24 hours, with solar winds likely rising to 500-550km/s (elevated). This coronal hole is both negative, which is favourable for geoeffective enhancements at this time of year (Russell-McPherron effect) and a persistent feature, which both support a relatively strong connection. However, the connection of this feature on the previous rotation was subdued, and current MOSWOC enlil modelling only suggests a weak enhancement, reducing confidence. Any coronal hole enhancement is expected to gradually decline day 2 onward (27 Feb) with solar winds easing to background again by the end of the forecast period.

Geomagnetic activity is expected to be mainly Quiet with isolated Unsettled spells. However the predicted onset of fast winds of CH01/-, on day 1 (26 Feb) will likely bring a spell of Unsettled to Active activity with a chance of peak G1 Minor Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	25	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

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Radio Blackouts - X-Ray Flares:

Moderate to Low activity is expected with further isolated M-flares considered likely. There remains a slight chance of isolated X-class flares from AR3590.

There are six numbered regions on the disc. AR3590 continues to dominate the flare risk probabilities, as a large spot near the north-centre disc, though with a recent very slight decrease in penumbral extent observed. This region is comprised of a large and strongly positive polarity leader which shares penumbra with a large negative intermediate spot, leading to a delta configuration. Although this is only a weak delta due to limited magnetic flux along the neutral separation line. There are further small delta spots, including one located east of the intermediate spot. The trailer of the spot remains much weaker, and the limited shear across the region limits the flare potential, however given this has produced the strongest flare so far of SC25 (X6.3), with little change to the region, similar sized eruptions remain possible.

The remaining regions have shown little change overall, however AR3595 in the northeast appears to be developing with a large number of small spots that are generally growing in size. A new region is rotating into view in the far northeast. This appears to contain a bipolar sunspot group and will be assessed further as it rotates further onto the visible disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	60
Very Active	R3 to R5 X Class	No	20	20	20	15

Figure 2: GOES 16/18 X-ray flux

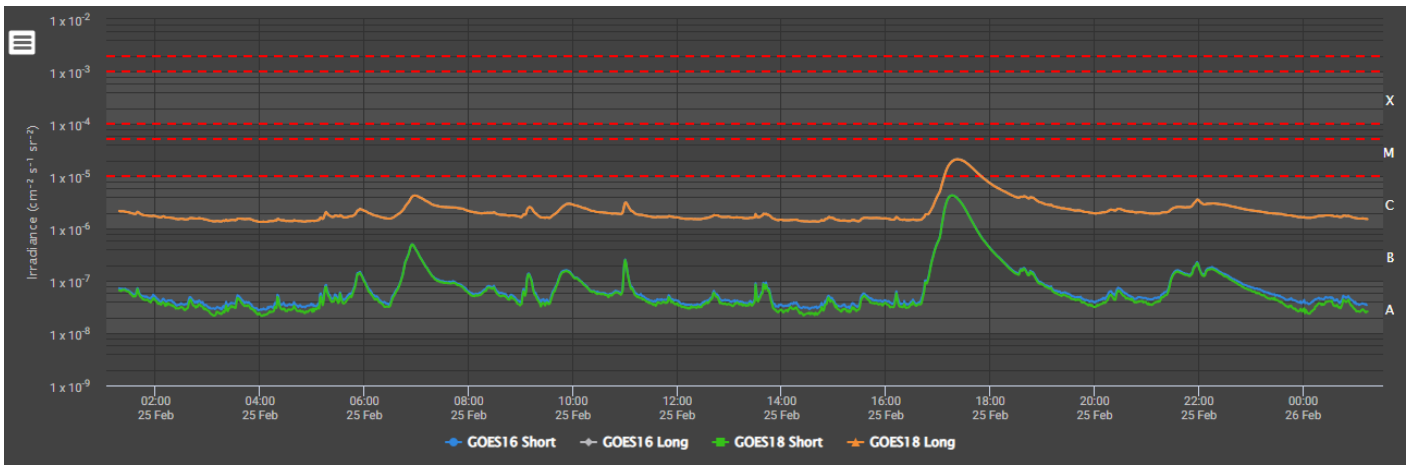

Figure 3: SDO imagery or AR3590 (Intensitygram and Magnetogram) at 26/0045 UTC

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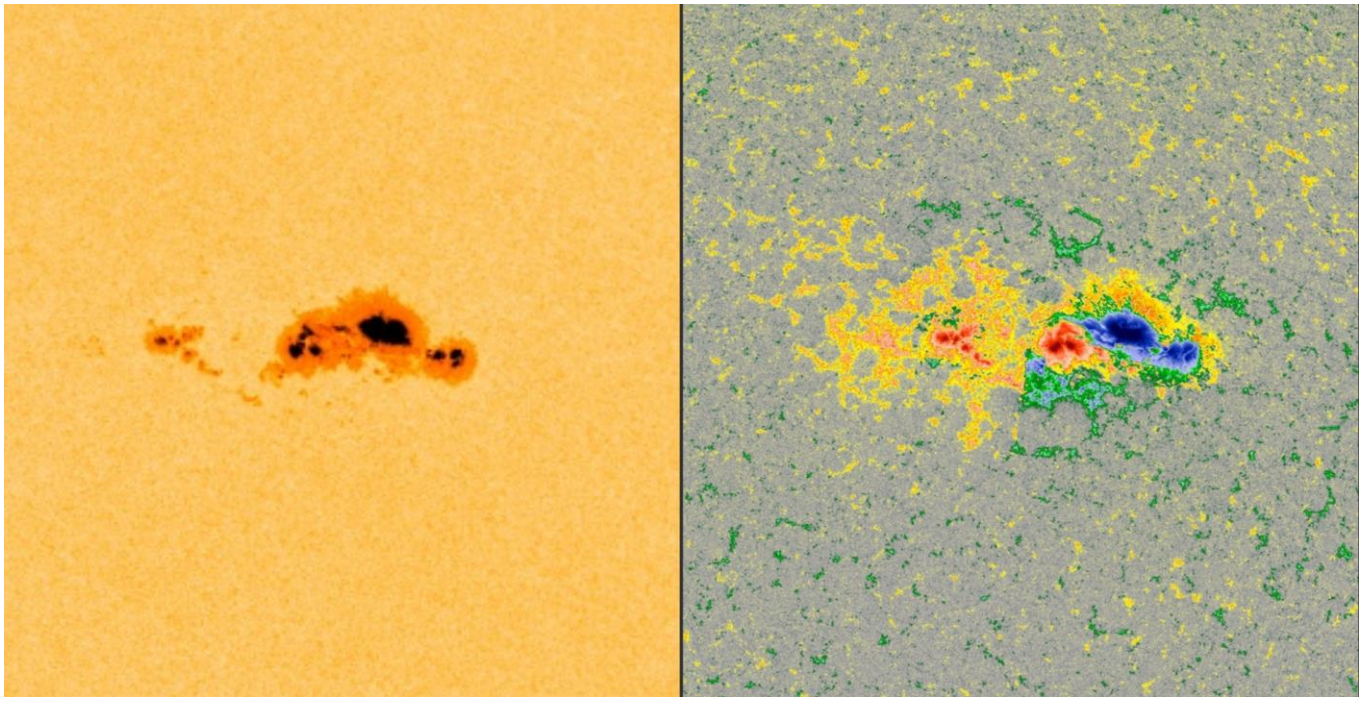

Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is at normal background levels. However, as AR3590 continues moves across the western disc any further strong flare activity will bring a chance of enhancing the observed proton flux at GEO, especially if those flares are eruptive. This will bring a slight chance of reaching S1 Minor Radiation storm levels, with a very slight chance of stronger storms being observed (S2+).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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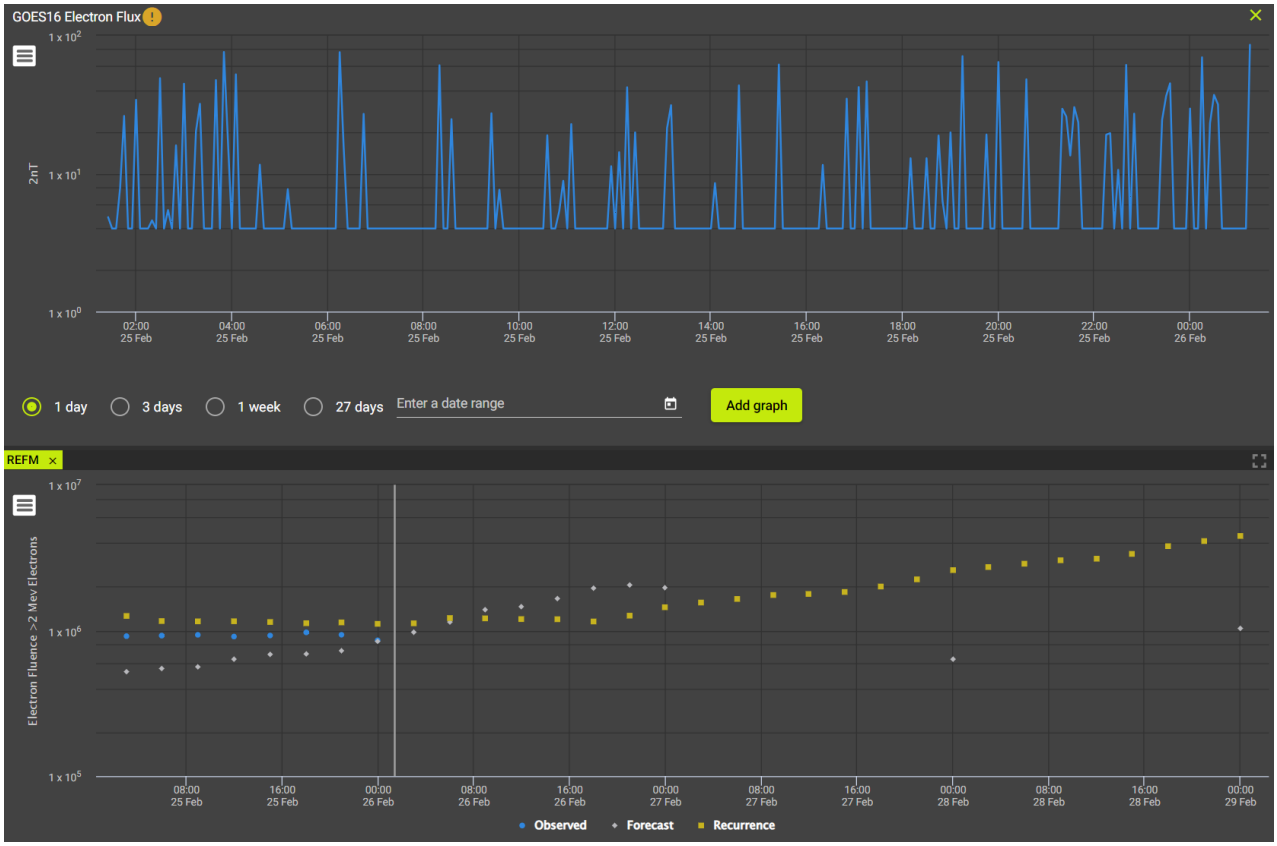
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 is currently at background. The expected enhancement from CH01/- is likely to increase populations through the Van Allen Belts, however confidence is low with how strong this enhancement will be. Initially observed at lower orbits, any enhanced flux should relax back to GEO through day 2 and day 3 (27-28 Feb), with the observed GOES-16 flux likely becoming Moderate with a chance of reaching High, primarily at diurnal maximum on day 3 or 4 (28-29 Feb).

The associated 24hr fluence is expected to remain below the Active (1e8 integrated pfu) threshold through much of, if not all of the period, but with a rising trend likely from day 2 (27 Feb). This will give a very slight chance of reaching Active fluence on days 3 and 4 (28 and 29 Feb).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: GOES16 >2MeV Electron flux (above) and REFM output with recurrence (below)



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